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ABSTRACT

This booklet describes a process for creative classroom problem solving that can be adapted to many types of problems. The booklet's five sections correspond to five phases of the problem solving process. Each section begins with a description of the phase and then provides suggestions for using that phase in the classroom. The sections conclude with case studies that illustrate the way a basic problem-solving process can be modified to suit a number of different types of situations. "Your Turn" boxes throughout the booklet will allow the reader to resolve a problem in his or her own life. The five sections address: (1) recognizing that an unresolved situation exists as a first stage of problem solving; (2) identifying the problem; (3) finding solutions including tools for generating ideas, suggestions for when the process gets stuck, and problem solving with students; (4) choosing from among alternatives including identifying criteria, decision making, adapting criteria, and problem solving with students; and (5) taking action such as looking at the results of the action and working with students in this phase. (Contains 20 references.) (JB)

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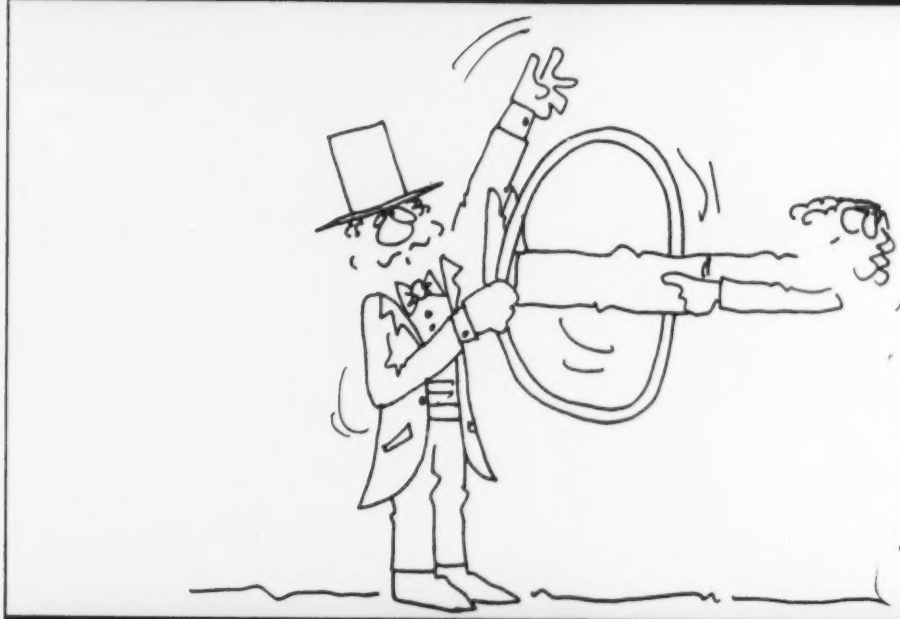
Resolving Mysteries



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A GUIDE TO CREATIVE PROBLEM SOLVING

Instructional Strategies Series No. 17

SDRL

ED 380 426

SP 033 743

Prepared for

The Saskatchewan Instructional Development and Research Unit

and

The Saskatchewan Professional Development Unit

by

Loraine Thompson Information Services Limited

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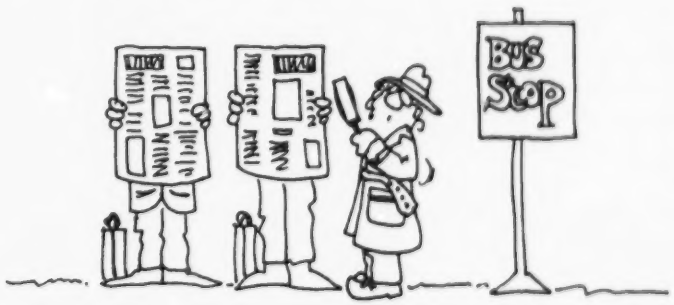


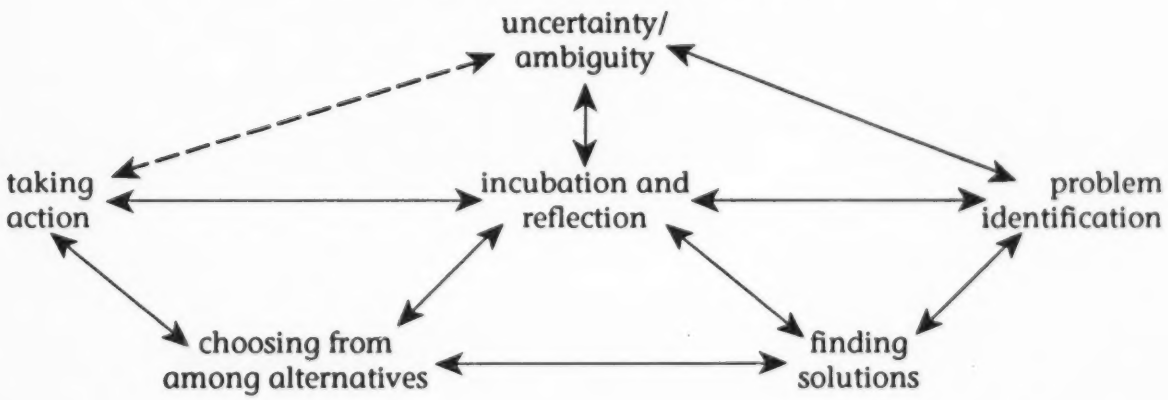
Introduction

Problems come in all shapes and sizes. If you want to move a large table to the second floor of your house and it won't go up the stairs, you have a problem. If your car won't start whenever it rains, you've identified a problem. If you want to present certain concepts through a dramatic presentation but aren't quite sure how to design the presentation, you've discovered a problem. If you inherit some money and are trying to decide what to do with it, you have a problem. If you have to deal with a co-worker who doesn't do her share, you've got a problem. As the examples above illustrate, problems can involve happy as well as unhappy circumstances. Basically, "a problem exists whenever the present situation is different from a desired situation or goal."[1]

All of us encounter dozens of problems of varying degrees of seriousness every week. There are no "right" or "wrong" answers to most of the problems that we encounter in daily life. Usually, there are many possible solutions.

This booklet describes a process that can be adapted so that it is suitable for use with many different types of problems. This process is illustrated below.

A Problem-Solving Process



Most problems begin with **an unresolved, ambiguous or uncertain situation**. Recognizing that an unresolved situation exists is the first phase of the problem-solving process.

Before the problem can be solved, it needs to be **clearly identified**. This is the second phase. There may be more than one problem in an unresolved situation.

The next phases involve **identifying possible solutions** and **choosing from among the alternative solutions.**

The final phase is usually to **take action** by implementing a solution, finding out if that solution works, if it needs to be changed or modified, or if a completely new solution is needed.

These phases are shown in linear fashion in the diagram, but in real life people often move back and forth between them. For some problems, the phases may occur in a different order than shown in the diagram, or two or more phases may be carried out at the same time. This is well illustrated in the case studies that conclude each section of this booklet. The same basic process is used in all of these case studies, but the phases are sequenced differently, and the emphasis that the various phases receive varies from one case study to another.

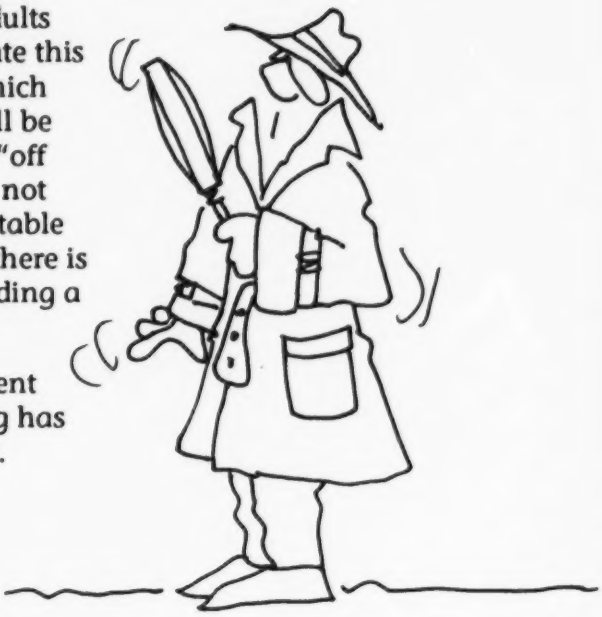
Incubation and reflection permeate all aspects of problem solving. Incubation involves putting the problem on the "back burner" – standing back and letting the elements work themselves through at a subconscious level. Sometimes problem solving is more productive if you don't try to force it too much. If you give the problem time to incubate, you'll find ideas popping into your head when you're walking, driving or relaxing; or you may wake up one day and the solution simply comes to you – fully formed.[2] Reflection involves analyzing the problem, the process that you are using to solve the problem and the solutions that you have generated.

Perspective is a consideration that influences all aspects of problem solving.

In our efforts to make sense of our experiences, we all construct our own understandings of the world in which

we live. This leads us to have different perspectives and different values. Two people who are in the same situation might feel quite differently about the situation because their perspectives differ. The fact that our perspectives influence the way we approach problem solving and the choices we make is referred to throughout this booklet.

A second consideration that influences problem solving is attitude. In order to solve problems creatively you need to be able to look at situations in a variety of ways, rather than seeking the "right" solution. Adults and children alike will be more able to demonstrate this type of creativity if their environment is one in which they are free to take intellectual risks. Students will be more likely to take risks if they know that new or "off the wall" ideas will be considered and discussed – not dismissed or criticized. They will feel more comfortable taking risks if they are in an environment where there is an emphasis on generating ideas, rather than finding a single "correct" answer.



For these reasons, creating a classroom environment that will provide a foundation for problem solving has been used as an example throughout this booklet.

Organization of this Booklet

This booklet has five sections (in addition to this introduction), one for each of the phases of the problem-solving process. Each section begins with a description of the phase and then provides suggestions for using that phase in the classroom. The sections conclude with case studies that illustrate the way in which a basic problem-solving process can be modified to suit a number of different types of situations.

The "Your Turn" boxes that appear throughout this booklet are intended to provide a structure that will allow you, the teacher, to resolve a problem in your own life. Once you have worked through the problem-solving process yourself, you will be better prepared to assist your students. You may want to write your responses to the "Your Turn" questions on a separate sheet of paper, rather than writing in this booklet.

Uncertainty/Ambiguity

Most problems begin with an ambiguous situation – a situation that makes you dissatisfied, uncomfortable, uncertain or causes you to search for answers.

Marsha Lewis, a grade eight teacher, faced such a situation when she tried to introduce problem-solving activities in her classroom.

During the first activity, most students sat in silence and didn't respond when she asked for ideas or suggestions. Midway through the lesson, a few of the more easily distracted students began to pass notes and whisper to each other. Marsha knew that there was a problem in her classroom, but she wasn't quite sure what it was.

It is important to note that what is an unresolved (and thus problematic) situation for one person may not be for another – it's a matter of perspective. For example, some teachers may be bothered by the papers and other junk that keep blowing into the school yard; others may not even notice the litter.

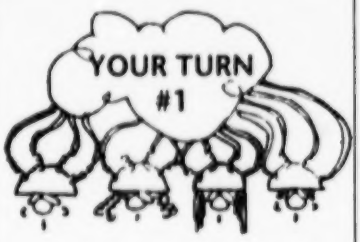
Problem Solving with Students

Students need to work through the problem-solving process many times in many different situations before they internalize the process and understand that it can be used in a variety of circumstances. At first, when students are learning the process, whole-class activities are most appropriate. Once students are familiar with the process, they can work in small groups or individually.

Most problems begin with an ambiguous, unresolved or uncertain situation. Students encounter many such

situations in their classes and in their school and community activities. A few examples of such situations include:

- ➢ frequent fighting and general rowdiness on the playground,
- ➢ Canadians' general dissatisfaction with elected officials,
- ➢ an assignment to create a soundpiece to accompany a poem, and
- ➢ an assignment to express the motion associated with their favourite sport through a visual form.



Think of an unclear, ambiguous or uncertain situation that you are facing. Perhaps the students in your class differ widely in ability, you are responsible for organizing the school's track meet this year, or you are feeling uncomfortable about the way that you relate to some of your fellow teachers.

Describe a problematic situation that you are presently facing. Don't try to pinpoint the problem, just describe the general situation.

Case Study

A grade two class is studying advertising. Today they are discussing television ads for toys. Some of the students have noted that ads aren't always truthful. Sometimes toys break or fall apart. Often they aren't nearly as much fun as they seem to be in television ads. Sometimes the toys are smaller than they seem to be on TV, or the colours aren't as bright. Bob Gervais, the teacher of this class, recognizes that this situation presents an ideal opportunity for a problem-solving session. He asks the students, "What problem are we facing here?" After some discussion, the students agree that the problem is how to get toy manufacturers to be truthful in their television ads.

He asks the students to brainstorm to identify as many solutions as possible to this problem. He reminds students of the rules for brainstorming – all ideas are accepted and recorded, no criticism of others' ideas, try to piggyback on others' ideas. The brainstorming session produces many ideas. A few of these include:

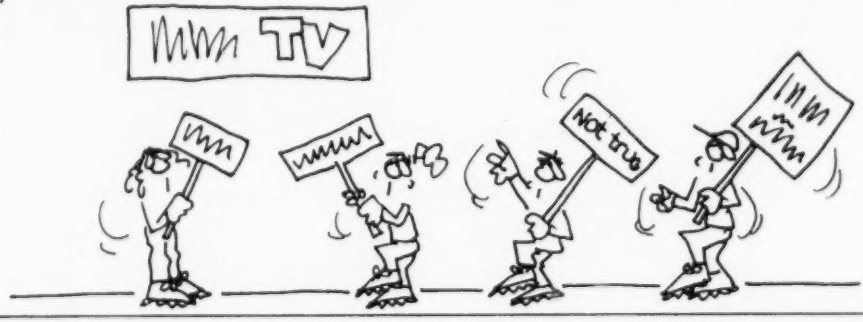
- picketing the TV station when it shows ads that aren't true,
- writing letters of complaint to the TV station or the store where you bought the toy if it isn't like it was shown on TV,
- returning toys that weren't like they were shown on TV and complain to the store, and
- reporting ads that aren't true to the police or the government.

Next, Bob tells the students that in order to decide which of these solutions is the best, they will need to develop some criteria. He explains the concept of criteria to them by telling them that criteria are rules that will help us make good decisions. He indicates that criteria usually involve factors such as cost, time needed, difficulty, and who will benefit. The students in his class develop the following criteria:

- must cost little or nothing,
- must be something that is easy for grade two students to do, and
- must not take too much time.

The students then assess their solutions against these criteria. They discover that some of their proposed solutions don't fit their criteria. For example, picketing the TV station is hard for grade two students to do and very time consuming. Writing to toy manufacturers would involve finding a lot of addresses, which is quite complicated for people of their age.

They decide that the best solution is to write letters of complaint to the TV station about ads that aren't true. Bob finds the address of the TV station and the students set out to implement their solution.[3]

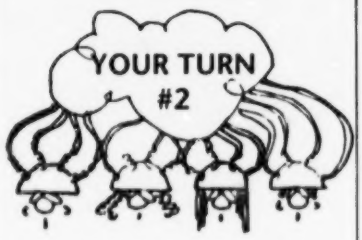


What's Your Problem?

Identifying the problem isn't always as simple as it seems. Sometimes you know right away what the problem is. For example, if you are trying to move a large piece of furniture to the second floor and it won't go up the stairs, the problem is obvious. But, if your car quits, the problem could be any one of several things. If the teachers in your school are arguing a lot rather than working together, the problem could be anything from a principal who believes in the philosophy of "divide and conquer," to one or two staff members whose personal problems spill over into the school. Similarly, if a student is having trouble reading, the problem could be anything from a visual impairment, to dyslexia, to lack of interest.

Often it is necessary to get more information before you are able to get a handle on a problem. When analyzing the situation in her classroom, Marsha realized that the problem could be any one of several things. She might not have explained her expectations clearly, the materials she was using might have been poorly written, the students might be unwilling to respond for some reason. There were numerous possibilities.

Marsha got more information about the situation in her classroom by asking students why they didn't participate in the lesson. Their answers included, "Because I couldn't figure out what answer you were looking for." "I didn't know the answer." "I read the textbook, honest, but that question wasn't in the textbook." "I didn't know what you wanted us to do." "I had an idea, but I didn't want to look stupid so I didn't say anything."



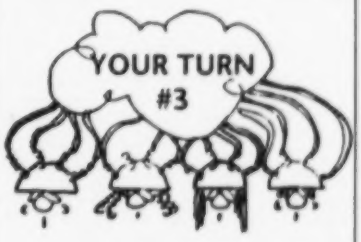
In Your Turn #1, you described an ambiguous, confusing or unclear situation that you are presently facing. Now identify the problem or problems associated with that situation. In order to identify the problem, you may need to ask questions or gather further information to clarify your thinking. You can gather information by talking to other people, analyzing your own thoughts and impressions, reading books or magazines, viewing videotapes, or observing the situation. Record the results of your data gathering below.

Data Gathering Method	Data
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

What is the problem that you are facing? If, in your analysis of the situation, you identified more than one problem, write the most significant problem below.

_____

_____



In any situation, the existence of a problem depends, at least partially, on your perspective.

Would the problem you described in Your Turn #2 be a problem for people whose values and priorities are different from yours? Why or why not?

Are there circumstances under which the problem you described in Your Turn #2 would not be a concern for you. Why or why not?

On the basis of her students' answers, Marsha concluded that her students were unfamiliar with situations where there is no single "right" answer and that they are unwilling to take a chance that their answer might be "wrong."

Some of the students didn't even seem to understand that there could be more than one answer in some situations.

The existence of a problem sometimes depends on your point of view. A three-day rain last June was a blessing for farmers who needed the moisture, but a big problem for the local golf club because it caused cancellation of the yearly tournament and considerable loss of money. His son's untidy room is a problem for Mr. Long who believes that his standards of neatness should apply throughout the family home. It isn't a problem for Mrs. Long who believes that Billy's room is his territory and that he should be able to set his own standards in his territory.

Marsha Lewis was sick for a few days. The substitute teacher who filled in for her praised her class lavishly in the staff room, "They're very focused on finding the right answer," she said. "I really like to see that. They don't waste time trying out a bunch of solutions that may not be right." Because the substitute teacher had different values and priorities than Marsha, she didn't perceive the students' focus on finding the "right" answer to be a problem. Just the opposite, in fact. She considered generating alternative solutions to be a waste of time.

Problem Solving with Students

When students encounter an ambiguous situation, they usually have to analyze it in order to identify the specific problem. Questions such as those below will be useful during this analysis.

- Who is involved in this problem?
- What materials, items, resources and things are involved?

- Where is the problem located?
- When is the problem happening? What are the deadlines, beginnings and endings associated with the problem?
- Why is this a problem? Why do the people involved feel as they do?
- How have other people tried to solve this problem in the past?[4]

Below is a list of specific problems to which students might apply their problem-solving skills. The problems are drawn both from school and community life, and from the subject areas.

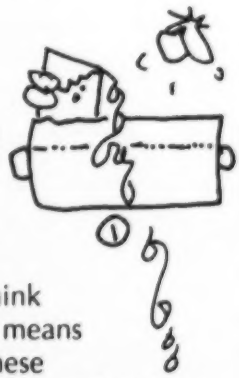
- How can we prevent all that paper and other junk from blowing into the school yard all the time?
- If you got left behind on the field trip tomorrow, what would you do?
- Should our school participate in the United Way? If so, what should we do?
- What should we do for our classroom Christmas party?
- How can I construct a self-propelled water craft without a propeller?
- What can our school do to help the victims of the earthquake in India?
- Our group represents a major industrial power of the late 19th century. Based on what we know about its economy and politics, what are our nation's prospects for the future?
- What should the federal government do to reduce unemployment?
- What should city council do to keep taxes at their present level?
- What can be done to prevent liquids from the Regina garbage dump from leaking into the underground water beneath the dump?
- How can I keep an ice cube solid for eight hours out of the freezer?

- How can I make this object look three dimensional in my painting?
- How can we structure our dramatic presentation so that we get our message across?
- How can I discover a number that is odd and divisible by two?
- How can I put movements together in a way that will be interesting for the audience and will convey a specific theme through dance?
- How can we design a game that will teach younger students the concept of multiplication?
- How can I cut, fold and glue this paper to create a pop-up greeting card?

Some problem-solving activities start not with a well-defined problem or question, but rather with a puzzle, a bit of whimsy, or a piece of interesting information. You can encourage students to recognize the problems that exist in the world around them and to apply their problem-solving skills by creating a problem-solving environment in your classroom. Some possibilities include:

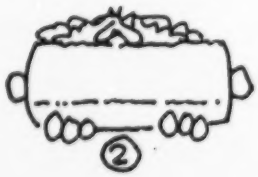
- displaying discrepant events in which students experience two or more seemingly contradictory things occurring at the same time,
- providing information about unsolved mathematics or science problems,
- displaying newspaper clippings or magazine articles about interesting or puzzling events, and
- displaying or handing out "brain teasers" or word puzzles.

Case Study

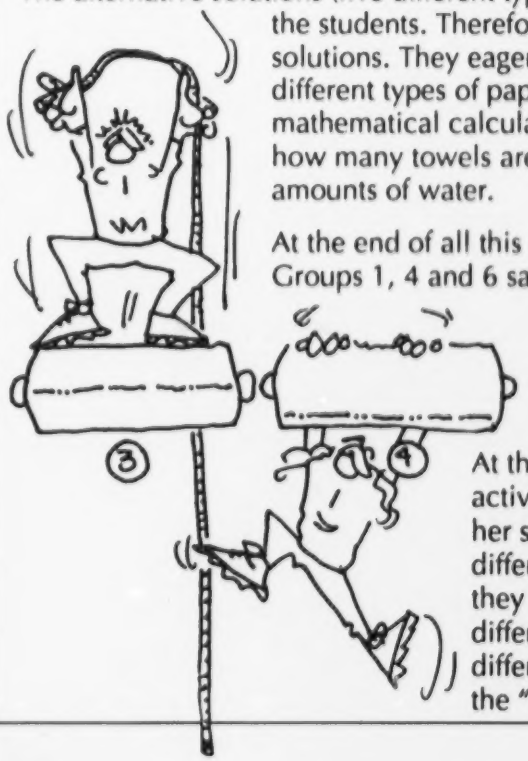


One day Sandra Cardinal, a grade seven teacher, brings five different brands of paper towels to school and tells her students to work in pairs to find out which brand is the best buy. Sandra tells her students that they are going to solve the problem step-by-step. She begins by asking the students, "What is the problem here? What does the term 'best buy' mean?" These questions generate considerable discussion. Some students feel that best buy means cheapest; others think that it means cheapest per paper towel. Still others think that best buy means the paper towels that are most absorbent. Sandra explains that all of these answers are correct. The students have identified different problems because they have different perceptions about what is important. Next, she asks students to identify the criteria that they will use to identify the paper towels that are the best buy. A few of the criteria that students identified were:

Groups 1, 4 and 6 – the towels that cost the least per roll,
Groups 2 and 7 – the towels that cost the least per individual paper towel,
Group 3 – the towels that cost the least per linear metre,
Group 5 – the towels that will absorb the most liquid.

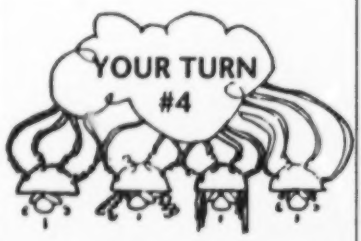


The alternative solutions (five different types of paper towels) have been provided for the students. Therefore, students don't need to identify possible solutions. They eagerly begin to evaluate the solutions (the five different types of paper towels) against their criteria. They do mathematical calculations, they unroll the rolls of towels to see how many towels are in each one, they mop up carefully measured amounts of water.



At the end of all this activity, the students have different answers. Groups 1, 4 and 6 say that "Fluffy" is the best paper towel because it is the cheapest. Group 5 says that "Cloud Puff" is the best because each metre will absorb 250 ml of water – more than any other brand.

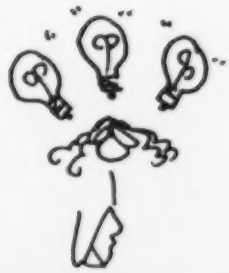
At the conclusion of this activity, Sandra points out to her students that they have different answers because they defined the problem differently and developed different criteria for identifying the "best" paper towels.[5]



In Your Turn #2 you identified a problem that you want to solve. Use some of the strategies described in this section to generate possible solutions.

Strategy	Solutions

Finding Solutions



There are many possible solutions to most problems. Usually it is better to identify a range of possible solutions than to simply implement the first one that you think of.

Sometimes solutions will come to you spontaneously and intuitively. However, when they do not, there are many different strategies that you can use to generate solutions. A few of these are described below.

When you are generating ideas and solutions, be sure to defer or suspend judgement. Write down all the solutions that you think of without judging them or trying to decide if they'll work or not. When you make a judgement prematurely, you limit the number of solutions generated and reduce the opportunity for truly creative or innovative approaches to a problem.

Tools for Generating Ideas

Tool: Trial and Error[6]

Purpose: To find a solution when you either don't have or don't want to use information that tells you one solution is more likely to lead to the goal than any other solution.

Process:

- Blind trial and error – pick a solution to investigate blindly, without considering whether you have already investigated the solution.
- Systematic – keep track of the solutions you have already investigated and investigate only unexplored solutions.

Example: Use this process for opening a combination lock when you have no information about the combination. Try every possible combination until you hit upon the right one.

Tip: Useful when the number of possible solutions is small, for example, a lock where the combination is a two-digit number. Inefficient when the number of possible solutions is large, for example, when the combination is a five-digit number. Inappropriate in many situations. For example, if the baby has a cold, giving her every medicine in the medicine cabinet to see which one works would be very dangerous.

Tool: Brainstorming[7]

Purpose: Brainstorming is used to generate many ideas, a variety of ideas, and unusual ideas.

Rules: Defer judgement
Seek many, many ideas
Seek new and unusual ideas
Piggyback on others' ideas

Process: Given an open-ended question, generate a large number of ideas about the question. Be sure to record all ideas for later use.

Example: List as many ideas as possible for improving the public phone booth.

Tips: Although one person can brainstorm, brainstorming works best in small groups of four to eight.

Tool: What If/Just Suppose

Purpose: Look at situations from many points of view; predict possible outcomes or consequences.

Process: Given a situation that is hypothetical or contrary to fact, generate many possible outcomes or consequences. Record all answers for later use.

Example: What if a new type of grain allowed Saskatchewan wheat farmers to double their production? What if our school vacation occurred during December and January instead of July and August.

Tips: Be sure to use questions that really are open ended!

Tool: Attribute Listing

Purpose: To increase observation skills and recognize many parts of a problem, and to lead to new ideas for change.

Process:

1. Select an object or situation.
2. List the characteristics of the object or situation.
3. Consider many aspects of the object or situation. For an object, you might consider shape, colour, weight, size and function. For a situation, you might consider time, place, people involved, activity taking place, who is affected by the activity.
4. Record all answers for later use.

Examples: List the attributes of a clock. Use each part as a springboard for new ideas to improve clocks (e.g., have the hands go up and down instead of in circles).

Consider all of the garbage that blows into our school yard (Where does it come from? Who produces the garbage in the first place? What type of garbage is it? Why do we consider it a problem? Is it concentrated in any particular part of the school yard?). Discuss, examine, and elaborate upon each idea.

Tips: Attribute listing can be done individually, in small groups, or in large groups.

Tool: Forced Relationships

Purpose: To make new connections by "linking" dissimilar objects or concepts from different areas of study.

Process:

1. Set one: Present an object, concept, task or open-ended question.
2. Set two: Present an unrelated object or concept.
3. By free association, record all connections that you see between the two sets to find new possibilities.

Examples: Let's improve the desk lamp. List the attributes of a desk lamp. Now list the attributes of, say, a roller coaster. What ideas can you force fit to improve the desk lamp? Roller coasters move on a track; could desk lamps move on a track?

Let's apply some mathematics to dance. Can you move in sequences that reflect mathematical patterns?

Tips: Forced relationships can be done individually or in large or small groups. Objects can be chosen by selecting pages at random from a department store catalogue or newspaper. Concepts can be chosen by selecting ideas at random from curriculum guides.

Tool: Idea Checklist

Purpose: To apply a specific "idea checklist" strategy to generate ideas.

Process: Use words or questions as a checklist or "springboard" for new ideas.

Substitute:	What can you substitute?
Combine:	With what can you combine this object or process?
Adapt:	What can you change or do differently?
Minify or Magnify:	How would it change if it were bigger, smaller?
Put to Other Uses:	Are there other uses for this object or process?
Eliminate:	Is there something that we can eliminate?
Reverse or Rearrange:	What could we reverse or put in a different order?

Record all ideas to use later.

Example: Use the words and questions above to improve the brown paper bag.

Substitute:	Leather instead of paper

Combine:	Handles with bag
Adapt:	Make the inside waterproof
Minify:	Make them much smaller, so they are easier to carry
Put to Other Uses:	Use as costumes for a play
Eliminate:	Eliminate the brown colour; use bright, attractive colours
Reverse:	Put a zipper opening in the middle of the long side, not a hole at the top.

Tips: The stimulus words need not be done in order. Finding new words for each letter can also be an interesting challenge (e.g., "Substitute" might become "Switch," "Combine" might become "Colourful").

Other concepts that you can use to generate new ideas include elaborate, describe, rearrange, classify, exaggerate, empathize, compare, associate, hypothesize, symbolize and separate.[8]

Tool: Imaging[9]

Imaging is the process of creating pictures in the mind. These pictures are an important way of exploring ideas, concepts or experiences. Images are closer to direct experience than words. Words are usually labels that describe experiences whereas an image involves reliving or anticipating the actual event.

Purpose: To help students break free of habitual ways of seeing things. To promote creative thought.

Process:

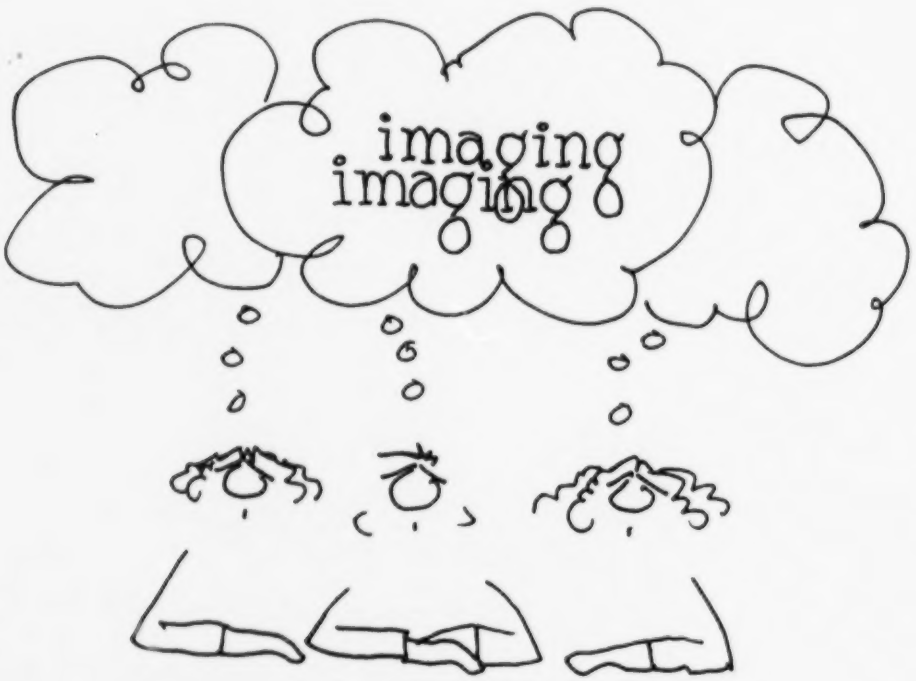
- ➢ Focus on your target problem. (30 seconds)
- ➢ What do you see, hear, smell, feel? (3-4 minutes)
- ➢ What are you doing? What actions are other people doing? (3-4 minutes)
- ➢ What is happening with the problem right now? (1-3 minutes)

➢ Slowly allow your images to fade away. (1 minute)

➢ Now return to your original setting. (30 seconds)

Tips: The process that you lead students through can be general or specific, depending on the situation. Keep your instructions open ended so that students can develop their own images.

Marsha Lewis decided to use some of the strategies outlined above in order to generate possible solutions for the problem in her classroom. The results of her work appear on the next two pages.



Brainstorming

How many ideas can I generate?	➢ Praise students who suspend judgement while generating alternatives. ➢ Ignore students who talk about the "right" answer. ➢ Emphasize the steps in the problem-solving process in detail rather than teaching it inductively. ➢ Explain to students that there often is no "right" answer when problem solving and that one of the goals is to generate many answers. ➢ Have students write about their feelings when there is a "right" answer and when there are many possible answers. ➢ Ask a colleague to observe my teaching to assess the extent to which I focus on "correct" answers rather than generating alternatives. ➢ Whenever possible have brainstorming sessions and have students vote on categories such as "most expensive solution," "least expensive solution," "hardest solution," "easiest solution," "craziest solution," etc.

What If/Just Suppose

If I change my perspective/basic values what would be the result?	➢ If I changed my perspective and decided that it was important for students to always reach a "right" answer rather than to generate many possible answers, I would no longer have a problem.

Attribute Listing

What are the attributes of a student who is a good problem solver?	➢ able to withhold judgement while identifying possible solutions ➢ able to look at familiar situations in new ways ➢ able to build upon the ideas of others ➢ able to create several possible solutions ➢ not afraid to suggest possible solutions

Idea Checklist

Substitute	I could substitute a videotape on problem solving for my verbal explanations. I could send some of the most reluctant students to another class and replace them with students who are experienced problem solvers.
Combine	I could combine my class with another class that is more skilled at problem solving so my students could observe.
Adapt	I could teach problem solving, but adapt the process, so that initially students have only a couple of alternatives to pick from.
Minify-Magnify	I could change my teaching to put less emphasis on problem solving. I could change my teaching to put more emphasis on problem solving, so that students are constantly exposed to problem solving.
Put to Other Uses	I could use the problem-solving process in other situations and see if these situations make it easier to understand.
Eliminate	I could eliminate some of the detail in the problem-solving process so that it's simpler.
Reverse or Rearrange	I could start with a solution to a problem and work backwards to show students how the problem was solved.

When You Get Stuck

For many problems, generating solutions is a process that takes place over time – days, weeks or even months. After an initial attempt to identify solutions, it is often useful to set the problem aside for awhile and give it time to incubate. More solutions may come to you when you least expect them. After several hours, days or weeks have elapsed, you may want to revisit the problem and identify the additional solutions that you have generated during the incubation period.

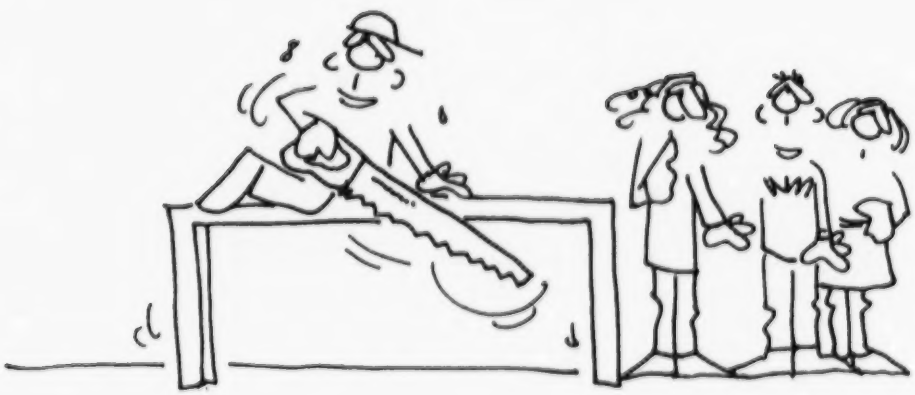
Sometimes, it is difficult to generate solutions to a complex problem because the problem is made up of several smaller problems. If you break the problem down into its component parts and then generate solutions for each of these parts, your task will be much easier. Even a problem that is as deceptively simple as, "What can we do about all the paper and garbage that keeps blowing into the school yard?" may need to be broken down. When you study this problem you might find that some of the litter in the school yard blows across a large open field near the school and some falls from trucks that pass the school on their way to a local manufacturing plant. In this situation, there are two components to the problem. There may be different solutions for each component.

Problem Solving with Students

Deferring judgement is critical during the "Finding Solutions" phase of problem solving. Accept all ideas and don't prejudge whether they are practical, whether they cost too much, etc.

Encourage students to build on each others' ideas. For example, a student could suggest that the table that is to be moved to the second story of a house might be sawed in half so that it will go up the stairs. Encourage other students to think of other ways that the table's physical structure might be altered so that it will fit up the stairs.

Use both whole-class and small-group sessions to generate ideas. Whole-class sessions will give students experience with some of the strategies that will help them generate ideas. Small-group sessions allow for more participation by individual students.



Case Study

A grade nine arts education class is in progress. The teacher, George Eng, has just asked his students to work in small groups to develop a soundpiece that creates suspense for a movie or television show. George decides to use the problem solving process as an organizer to help students address the problem that he has presented to them. Before students actually begin work on their soundpieces, he discusses the process with them.

➢ **Problem** – The problem is generally defined, but students may also wish to add more specific criteria. George decides not to play theme music from existing programs as examples of suspense. He wants the students to develop their own ideas about what is suspenseful. He tells students that they can use instruments, voices or other objects, such as metal or paper, to create sounds. He asks them to reflect and discuss ways that the elements of music and principles of composition might be manipulated to create a feeling of suspense.

➢ **Develop Criteria for Judgement** – In this problem, developing criteria will come before finding solutions because students will probably develop their soundpieces step-by-step. As they develop the soundpiece, they will assess it against the criteria. If the musical phrases fit the criteria, students may retain them in their soundpiece; if the musical phrases don't fit their criteria, students may abandon them or adjust them appropriately. George's class developed the following criteria for their soundpieces:

- must convey the feeling of suspense,
- must demonstrate the composition principle of tension and resolution,
- must be original – not a variation on an existing theme,
- the sound compositions must reflect prior learning of the elements of music and the principles of composition, and
- all members of the group must contribute equally.

Students agreed that they could use tape recorders and peer evaluation to determine whether criteria are met.

➢ **Find Solutions/Apply Criteria** – In this situation, these two phases occur at the same time. Students develop musical phrases, evaluate them against their criteria, and then either keep or reject them.

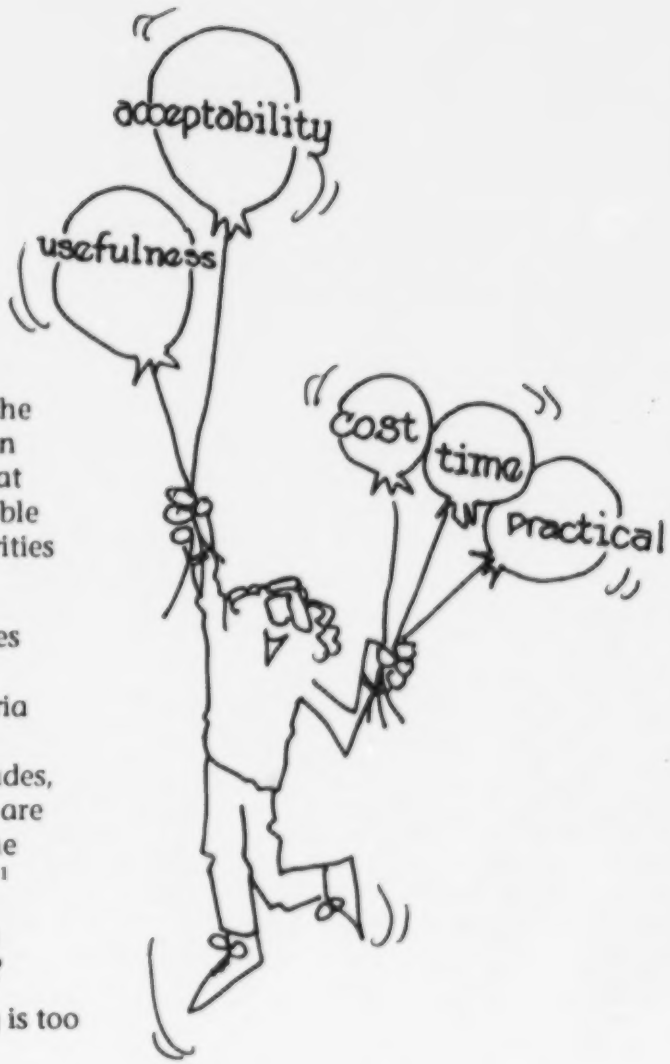
➢ **Take Action** – The final phase in this assignment is to put all components of the soundpiece together, perform the completed piece and assess the completed piece against the criteria. Students can ask themselves, "Did we meet our criteria?" "How could we change the soundpiece so that it is more suspenseful, or so that it sustains the suspense longer?"[10]

Choosing From Among Alternatives

Identifying Criteria

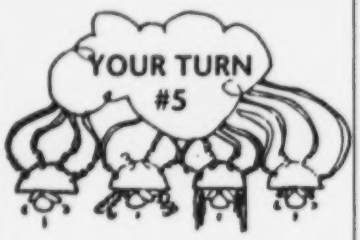
During the "Finding Solutions" part of the problem-solving process, you probably generated several possible solutions.

Now is the time to sort out those solutions and to select the ones that are best for your particular situation. There is rarely one "best idea" or "best solution." The solutions that are best for you depend upon your values and priorities. The solution that seems best to you might not be at all suitable for another person whose values and priorities are different from yours.



Choosing from among alternatives involves developing criteria – rules upon which a judgement or decision can be based. Criteria come from many sources including your accumulated knowledge, values and attitudes, feelings and observations. Although there are many different types of criteria, some of the most common categories are listed below.[11]

- **Cost** – How much will it cost? What is a reasonable cost? What is too expensive?
- **Time** – How long will it take? How long is too long? How long is too short?
- **Practicality** – How easy will it be to implement? Do we have the resources we need? Does it fit the circumstances?
- **Acceptability** – Will I like it? Will other people like it? Will people accept and promote this solution?
- **Usefulness** – Will it work? Will it do the job it is supposed to?



Develop a list of criteria you can use to evaluate the possible solutions to the problem that you identified in Your Turn #2. Use the headings "cost" "time" "practicality" "acceptability" and "usefulness" if you wish, or develop your own headings.

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In any given situation many different criteria are possible. For example, two people who are in exactly the same situation may have different views about what is a reasonable cost or a reasonable amount of time. One might consider ease of implementation to be very important while the other may attach little importance to this consideration. Neither person is right or wrong. The criteria that each selects reflect different views of the world and of what is important.

Marsha Lewis developed the list of criteria below to evaluate the possible solutions she generated to her problem.

- **Cost** – Can't cost more than $100 (her yearly allocation from the school's discretionary fund).
- **Time** – Must be something that will produce results within four or five months, so that I can see some development in the students.
- **Practical** – Must not be a drain on my time and energy. Can involve other teachers but not to the point where it becomes an imposition.
- **Acceptability** – Students must like it and be willing to work with it. It must be acceptable to me and must reflect my philosophy of education.
- **Usefulness** – Must be effective, that is, it must produce some results over time and make students less focused on identifying a single "right" answer during problem solving.
- **Transferability** – Are the skills that students learn transferrable to new situations?

All criteria aren't equal in value. Some are more important than others. Marsha Lewis decided that the most important criterion to her was acceptability. If the students didn't like the strategies that she selected to encourage them to generate many possible solutions instead of just one, and if she, herself, didn't feel comfortable with these strategies, the whole thing was a complete waste of time. Her second most important criterion was usefulness. If the strategies that she selected didn't produce a noticeable change in students' ability over a period of several months – forget it.

Decision Making

Decision making is the stage at which you use the criteria that are most important to you to assess the possible solutions that you generated.

The solutions that Marsha Lewis selected and her reasons for selecting them appear below.

Solution	Reason for Acceptance
➢ Have brainstorming sessions and have students vote on categories such as "most expensive solution," "least expensive solution," "craziest solution," etc.	➢ Kids love contests, games, "far-out" things.
➢ Explain the steps in the problem-solving process to students. ➢ Explain (repeatedly) that in most cases, the objective is to generate as many ideas as possible and to suspend judgement until the end.	➢ Kids respond very well to rational explanations – seems to make them feel mature. ➢ This approach has worked well in the past.
➢ Have another teacher observe my teaching. Perhaps I am unconsciously steering students toward a single answer.	➢ Very consistent with my philosophy of teaching. I believe that the teacher is an important role model and that I must demonstrate the behaviour I want to adopt.

In Your Turn #5, you developed a list of criteria to evaluate possible solutions to your problem. These criteria reflect your particular perspective on the world and your value system. What sort of criteria might be generated by someone who is facing the same problem but has a different perspective than you?

Assess the possible solutions to your problem against the criteria you identified in Your Turn #5. Below identify the solutions that seem best to you and the reasons for your acceptance of these solutions.

Solutions	Reasons for Acceptance

Below identify any solutions that would be absolutely unacceptable to you and the reasons why.

Solutions	Reasons for Rejection

Marsha also rejected some possible solutions outright for the following reasons:

Solution	Reason for Rejection
➢ Ignore kids who focus on finding the "right" answer.	➢ Doesn't fit with my philosophy of education. ➢ Kids would dislike this approach and class morale would decline.
➢ Change my approach to emphasize "right" answers and forget about problem solving or generating multiple solutions.	➢ Totally unacceptable to me, personally.

Adapting Criteria

The last few pages described a process in which you develop criteria for judgement and then weigh all of your possible solutions against these criteria. This can be a time-consuming and, occasionally, complex task. In some situations you might choose to modify the process. For example:

➢ Sometimes you may not examine every possible solution. For example, previous experience has shown that the best tasting apples are usually bright red and firm, with no bruised spots. You might pick the first 12 apples out of the barrel that meet these criteria, rather than examining all the apples in the barrel before making a decision.[12]

➢ One criterion might be far more important than others. You can do an initial sort of all your possible solutions on the basis of that criterion alone. For example, you are looking for an apartment to rent and cannot afford to pay more than $500 per month. You can reject all apartments that cost more than $500 per month.

Problem Solving with Students

Sometimes, students will be unable to agree on criteria or on the importance of various criteria. When this happens, it is usually because students' underlying perspectives are different. For example, in consumer studies some students may say that underground parking is an important criterion for choosing an apartment; others may say that proximity to a bus stop is. These different views relate to whether the students are car owners or not.

In science class, students may disagree on criteria for determining the use of a particular piece of land. Some may say that profit is the most important consideration; others may emphasize preserving the natural environment. This difference relates to students' fundamental value system and world view.

When students differ in their perceptions of important criteria, it is often useful to develop two sets of criteria and then follow through by making the same decision using the two different sets of criteria. Very likely, different solutions will emerge and students will be able to see that the solution to any specific problem depends upon your underlying values, beliefs, and purposes.

Case Study

George Eng has asked the students in his grade nine arts education class to choose a topic they would like to create a dance about from a list of topics they had brainstormed earlier in the year. The students decided to create a dance on the theme of "competition and sports." Even though the students were experienced at creating dances, George knew they needed guidance throughout the creative process.

George discussed the objectives with students for this dance experience and encouraged them to incorporate dance concepts they had learned earlier in the year. The students were to solve the following problem.

Problem: Students are to express their own ideas about competition and sports in their dance compositions.

George began the project with a whole group discussion about the positive and negative impact of competition and sports. George asked the students to think of how competition could be portrayed in dance. He and the class created a concept map with competition and sports as the central idea. From the concept map, they decided the compositions should include the following ideas. These became the criteria against which the dance compositions would be compared or assessed. The compositions should:

- demonstrate tension
- include opposing relationships
- include variety and contrast in shapes and dynamics.

George asked the students to collect images of athletes in action which displayed some of their ideas. The images could be magazine illustrations, art works and photographs such as Polaroid pictures of sporting events. Keeping their concept maps in mind, the class looked critically at the images to see which shapes might be used for movement exploration.

To help students generate movements, George asked them to memorize the body shapes found in the images and, in pairs, to explore several different ways of incorporating the shapes into their movements. For example, they could explore different ways of moving into and out of the shapes and they could try different ways of making the shapes travel. Students were directed to explore both locomotor and nonlocomotor movements.

As students developed their movements, George asked them to explore the ideas from the concept maps (opposing relationships, tension, variety and contrast in dynamics and shape) as well as any other ideas they might have had. He encouraged students to fully explore and develop their movements by asking them to experiment with doing a movement, for example, backwards, upside down, while sliding on their backs, at different speeds and so on.

Using the same criteria, students selected the movements they thought best conveyed their ideas about competition and sports. They sequenced these movements using their understanding of the principles of composition. Again, George encouraged students to try several different ways of sequencing the movements before finalizing the compositions.

George understood that the students would not know if their compositions were conveying their ideas until others had responded to them. He asked the students to show the compositions as works-in-progress to another pair to get their responses and help in refining the work. The students discussed the compositions in relation to the criteria they had set to assess how each group had solved the problem in its own unique way. The students also tried some of their peers' suggestions for improvement.

To finalize the dance compositions, the students incorporated the suggestions they thought would be effective and any other ideas they had for refining their work.[13]

Looking at the results

acting upon your decision

Taking Action

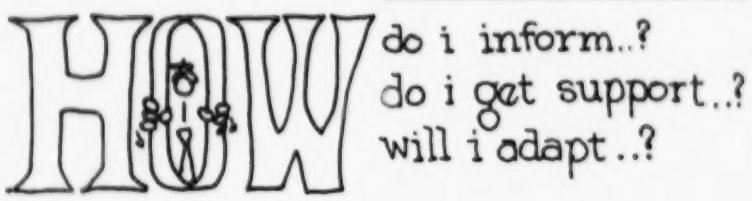
After you have made a decision about the way to resolve a problem, there are two more steps to be taken: acting upon your decision and looking at the results of your action.

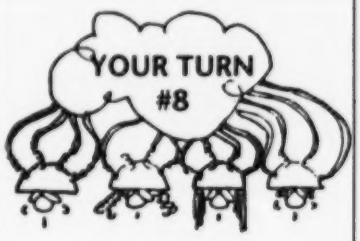
Acting Upon the Decision

Acting upon your decision may involve a single activity such as moving a table to the second floor. More often, however, it involves many interrelated activities. For example, the activities that Marsha Lewis planned to undertake to make the climate in her classroom more conducive to problem solving are all interrelated.

Sometimes a problem has an ending; once the table is upstairs, that particular problem is solved. But many problems don't have a specific ending. There will never be a time when the problem-solving climate in Marsha's classroom is "perfect" and she no longer needs to pay attention to it. This is a problem without a definite end, only degrees of success.

Further, the process of acting upon a decision that has been made to resolve a problem can, in itself, create a whole new set of problems. "How do I inform people of this activity?" "How do I get their support?" "How will I





Earlier in this booklet, you identified a solution to a problem that you are facing.

What are some of the new problems that may arise when you are implementing your solution? What are some of the questions that you will need to ask yourself?

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Did you follow the problem-solving process as it appears in the diagram in the introduction to this booklet or did you modify it as was done in some of the case studies in this booklet?

If you modified it, describe your modifications below.

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adapt the decision for changing circumstances?" are some of the questions that often occur during implementation.

Looking at the Results of the Action

Looking at the results of your action can help you answer several questions.

- **Was the solution effective?**

  Did it work or must I look for another one? Do I have to modify my original solution for maximum effectiveness?

- **What further action is needed?**

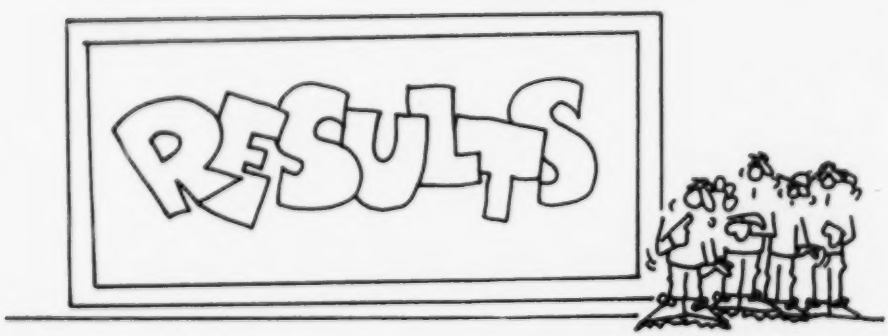
  The solution to one problem may be the beginning of another one. For example, when the problem-solving climate in Marsha Lewis's classroom improves somewhat, she may then want to focus on developing her students' skills in specific phases of the problem-solving process. This would necessitate a new problem-solving cycle in order to identify the areas where work is needed and the activities that would be most useful.

- **What did I learn from this process?**

  How can I apply my new learning in other situations? How can I change or adapt the problem-solving process for other situations?

- **How can the solution be strengthened?**

  Can we make the solution more comprehensive or more flexible? Can we include more people in the solution?



Problem Solving with Students

Reflection

Reflection should be the final phase in any student problem-solving activity. After students have worked through the phases of the problem-solving process, ask them to identify what they did – the steps they followed. Outline the process on the board, assisting students to identify the steps, when necessary. Then discuss how this process can be applied to other situations in the future, or remind them of how they have used it in the past.

Remember that students need many experiences with the problem-solving process before they internalize it and develop the ability to apply it to a variety of situations.

Evaluation

It is not appropriate to "grade" a child's solution to a problem. However, when assessing the extent to which students' problem-solving skills are developing, you may wish to consider the following points.

- The quality and quantity of ideas generated when the student is identifying possible solutions. Look for flexibility and original ideas.
- The student's ability to identify and rank criteria upon which solutions are chosen.
- The student's ability to explain his or her reasons for choosing a particular solution. "Whether a student picks a solution because it is the least expensive, the prettiest, the most imaginative, the most likely to succeed, or for any other reason, the very act of thinking about the basis for choice allows the student to develop an understanding of the subtle forces that lead us to make one choice over another."[14]
- The student's ability to describe or write down the process that she or he used to solve the problem.
- The extent to which a student can apply the problem-solving process in another situation. You might give students a hypothetical problem and ask them how they would use the same process to solve the hypothetical problem.

Case Study

Louisa, a grade two student, is having trouble reading. Her mother comes to see Betty Giesbrecht, Louisa's teacher. "What can I do to help Louisa at home?" she asks. Immediately, Betty gives her half a dozen suggestions. To the casual observer, it may not be obvious that Betty has worked through most of the phases of the problem-solving process, but in fact she has.

She has worked regularly with Louisa over the past few months and has spent considerable time thinking about this student and analyzing why she has trouble reading. Betty had the problem identified long before she met with Louisa's mother.

When Louisa's mother asked for suggestions, Betty ran through a mental list of two or three dozen things that parents can do to help children with their reading. She generated these solutions on the basis of her past experience and on reading she had done. She mentally evaluated this list of solutions against some criteria specific to Louisa's problem and narrowed her original list of two or three dozen solutions down to six that were most suitable for this particular student.

She implemented a solution to the problem when she made the suggestions to Louisa's mother.

Conclusion

Problem solving is a practical skill. It equips students to deal with the large and small problems, puzzles and dilemmas that they will face every day both now and in the future. Problem-solving skills have other benefits as well. When students feel that they have the skills and capacity to deal effectively with problems, they feel empowered; their self-esteem increases. They are better equipped to live and work in a pluralistic, democratic society where all individuals have responsibilities not only to themselves but also to society as a whole.

For Further Reading

Bagley, M.T. (1987). *Using imagery in creative problem solving.* New York, NY: Trillium Press.	*Problem solving occurs at the intuitive level as well as the rational level. This book describes how imagery can be used to generate solutions to problems and to help students break free of conventional thinking when solving problems.*
Bransford, J.D., & Stein, B.S. (1984). *The ideal problem solver: A guide for improving thinking, learning and creativity.* New York, NY: W.H. Freeman.	*A somewhat academic discussion of problem solving that deals with this issue at a theoretical as well as a practical level.*
Burns, M. (1976). *The book of think: Or how to solve a problem twice your size.* Boston, MA: Little, Brown.	*Designed to encourage divergent, creative thinking as well as to describe systematic problem-solving processes, this book is simply written and well illustrated. Although it is almost 20 years old, it is still as relevant as the day that it was written.*
Ellis, J.L. (1987). *Handbook of creative problem solving techniques.* New York, NY: Trillium Press.	*Ellis describes a number of techniques that can be used to generate solutions to problems. She also discusses a number of ways for analyzing and categorizing problems.*
Isaksen, S.G., & Treffinger, D.J. (1985). *Creative problem solving: The basic course.* Buffalo, NY: Bearly.	*Treffinger is one of the foremost authorities on teaching problem solving to students and has developed a process that appears in much of the literature on this topic. This book outlines his process in detail and provides many suggestions and ideas for teachers.*
Thornburg, P., & Thornburg, D. (1989). *The thinker's toolbox: A practical and easy approach to creative thinking.* Palo Alto, CA: Dale Seymour.	*The Thornburgs identify 16 different techniques that can be used to generate solutions to problems. They also provide 59 challenge problems to which these techniques can be applied.*

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